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FORTHCOMING MEETINGS

TUESDAY, 3RD JULY, at 2.30 p.m. '*Peaty Terrain: its influence as a factor controlling development in Great Britain and Canada*', by Norman W. Radforth, M.A., Ph.D., Professor of Botany, McMaster University, Ontario. (The paper will be illustrated with a film and lantern slides.)

WEDNESDAY, 4TH JULY, at 3 p.m. Annual General Meeting (see Notice below). Tea will be served afterwards.

ANNUAL GENERAL MEETING

The Council hereby gives notice that, in accordance with the Bye-Laws, the Two Hundred and Second Annual General Meeting, for the purpose of receiving the Council's Report and the Financial Statements for 1955, and the election of officers and the amendment of the Bye-Laws, will be held on Wednesday, 4th July, 1956, at 3 p.m., at the Society's House.

(By Order of the Council)

KENNETH WILLIAM LUCKHURST,
Secretary.

BURSARIES EXHIBITION

A small selection of the winning and commended designs in the Society's Industrial Art Bursaries Competition, which were included in the recent Exhibition at the Society's House, are at present on view at Falmouth School of Art, Kerris Vean, Woodland, Falmouth, Cornwall, where they will remain until 11th June.

The entire exhibition as originally shown at the Society's House will be exhibited in Belfast and Birmingham later this year.

EXCHANGE OF BENJAMIN FRANKLIN DOCUMENTS

The introduction of Benjamin Franklin to the Society of Arts came about through the forwarding to the Society by Dr. Alexander Garden of a copy of Franklin's 'Proposal for Promoting Useful Knowledge among the British Plantations in America'. This paper, in which Franklin set out proposals for the establishment of the American Philosophical Society was read to a meeting of the Society of Arts in June, 1755, when the plan 'was judged to be an excellent design if it can be put in practice', and it was decided that it should be preserved in the Society's Guard Book. Shortly afterwards William Shipley, the Secretary, wrote inviting Franklin to become a Corresponding Member, and Franklin agreed, saying that although as a Corresponding Member no subscription was due from him he wished to give to the Society 20 guineas, which was the amount of the life composition fee of an Ordinary Member.

These events have recently had an interesting sequel. The American Philosophical Society possesses no contemporary copy of the 'Proposal for Promoting Useful Knowledge', although it is virtually its foundation document, and recently approached the Royal Society of Arts with a view to effecting an exchange. The Council has now agreed to send the Society's copy (which is in manuscript) to Philadelphia and has accepted the generous offer of the American Philosophical Society to send in exchange a list of members of the Society of Arts in September, 1755, which was attached to Shipley's letter of invitation to Franklin, together with '1,000 Dollars as supplement to Franklin's original 20 Guineas'.

THE SOCIETY'S CHRISTMAS CARD, 1956

Particulars of the prices for the Society's Christmas card are now available, and are given on the order form at the back of this issue of the *Journal.*

AUTOMATION

A paper by

THE RIGHT HONBLE. THE EARL OF HALSBURY, F.R.I.C., F.Inst.P.,

Managing Director, National Research Development Corporation, a Member of Council of the Society,

read to the Society on Wednesday, 9th May, 1956, with the Right Honble. Lord Latham, J.P., F.A.C.C.A., F.C.I.S., a Member of Council of the Society, in the Chair

THE CHAIRMAN: I am greatly pleased to preside over this goodly gathering assembled for the paper we are to hear on 'Automation'.

Surely at this time few subjects could be more topical, or more in need of clarification, than that which has suddenly burst upon an unsuspecting public under the description of 'automation'. This word is now on the lips of the multitude, if only becaise of the unhappy events currently taking place in the industrial Midlands. In truth, the word 'automation' is in danger of becoming a sort of bogey; perhaps largely because it has passed into the currency of common speech before its meaning is properly understood. It is of national importance that automation should be understood for what it really is, and not for what it is misunderstood to be.

We are thus very fortunate to-day to have the Earl of Halsbury to help us, and the wider public outside, to a proper understanding of the real meaning, purposes and significance of these new or developed techniques now compendiously called 'automation'.

I know of no person better qualified to do so than he: for his wide practical experience in industrial engineering and his recognized scholarship and standing in the field of research as applied to scientific and mechanized techniques alike fit him, in an outstanding degree, to perform this valuable and important task. Lord Halsbury has held a number of positions of great scientific distinction, which I need not detail here; and he is at present Deputy Chairman of the Parliamentary and Scientific Committee and Chairman of the National Institute of Industrial Psychology. A most fortunate circumstance this latter: for psychological considerations will inescapably occupy a leading place in the successful acceptance of the application of automation by the workpeople, not only in the factory, but in the office as well: for automation will also push through the office door as well as the factory gate.

But whatever misconceptions may be current about automation, it is, I think, clear that application of the new and developed techniques it comprehends and their widening and intensified uses, which are demonstrably practicable, is bound to come. For they are in the direct line of progress; replacing man-power, both physical and mental, with machine-power, giving a vastly increased rate of productivity, with greater efficiency and economy. They cannot and, indeed, ought not to be resisted, for by and through them we can secure a rising standard of living at home, and bring broadening relief and succour to the millions of undernourished people in the world at large.

We may indeed be on the threshold of immense potentialities: of something in the nature of another industrial revolution and an era of multiplying prosperity. Encouraged as we may be by this beckoning prospect, let us not overlook that we are likely to be confronted with many problems and difficulties; for the widespread

application of automation will undoubtedly bring in its train great economic and social changes, transitional and permanent, in the design and structure of our economy and in the pattern of our society. The social implications are many; and there will be many initial dislocations in our existing economic set-up. The present distribution of labour and its skills between the skilled, the semi-skilled and the unskilled will change. A new rhythm of work may well emerge and develop; more leisure should become available, requiring us to work out a new rhythm for the place and enjoyment of leisure. Already in some quarters, where the only need for the worker is to supervise and watch, the question of loneliness has arisen. Then there is the physical strain of the tempo of operations, where man and the faster mechanical processes are in associated function. These are but some of the problems of adjustment which will arise. No doubt we shall resolve them in due time; sooner, I hope, rather than later.

Perhaps the most acute problem will be of the fear of redundancy and consequent under-employment or unemployment. We may think that there are no grounds for this, but it is there in the minds of workpeople. Nor will it be easily exorcized by the assurance that, as economic history seems to show, in the long run labour-saving techniques provide more employment and not less. The fear of unemployment, however, is an immediate and personal one, and the worker's experience of the past is still too near for him to disregard it. Nor is the distribution of excess labour in one place to other places an easy answer; for workpeople have their deep social roots where they live, which cannot be lightly torn up without regret or protest, even if the present housing situation easily permitted them freely to move around.

In short, who is to bear the transitional burden of automation and who is to enjoy its fructifying benefits? It will, I think, be no more than social justice to recognize, as a claim on the benefits ensuing, some reasonable and proper provision for relief of any actual hardships, if they arise from redundancy directly due to automation. Furthermore, the benefits as they fructify should be fairly distributed between owners, workpeople and consumers, remembering always that we are all consumers and also, of course, that we are all citizens. If the enjoyment of the rewards of automation are known to be and are seen to be shared in a just and equitable way then all persons of goodwill can be fairly expected to co-operate in seeking the maximum results from this, yet another, stride forward on the road of progress.

I trust you will pardon my rather lengthy interposition between you and the lecturer, for it is he whom you came to hear, not me. I hope I have not impinged unduly upon what he has to say. But in the thickening confusion that surrounds the subject of automation I felt entitled to express one or two thoughts of my own: maybe at the risk of adding to the confusion! Indeed, I believe that Lord Halsbury may well disagree with much of what I have said: if so, then it may add to the interest and, perhaps, the gaiety, of this afternoon's proceedings!

The following paper was then read:

THE PAPER

I shall assume that you have all heard the word 'automation', but I shall not assume you all know what it means. In fact, it is widely used in so undefined a sense that the few people who claim to know what it means rarely find themselves in very satisfactory agreement with rival claimants to the same knowledge. My first concern will therefore be to make it clear what I am talking about.

I will begin by saying that we are concerned with the relation between sub-species and species. Automation is a sub-species of which 'mechanization' is the species. I think you all know what I mean by 'mechanization'. It consists of substituting machine activity for human activity. 'Substitution' is what we

are concerned with. If there is no 'substitution', then the word 'mechanization' is inappropriate. A telephone for example is not a 'mechanization' of anything but an automatic telephone exchange is, because human switchboard operators are replaced by an electromechanical set of devices.

Automation being regarded accordingly as a sub-species within the species 'mechanization', what defines it? I think I can give a fairly satisfactory answer by stating that where we are mainly concerned with finding a substitute for nerve and brain, we can talk of automation, but where the process concerns mainly muscle and brawn we can talk of mechanization. Since all nervous activity is manifested finally in muscular activity the distinction cannot be a hard and fast one, but you may picture the muscles for which a substitution is effected by automation as those of the fingers, larynx and eyeball rather than those of the biceps, shoulders and thighs, the substitution of which is effected by mechanization in the narrow sense of the word.

Why have we suddenly found the need to coin a new word—automation—to describe this group of substitutions? Has a new technique emerged? I think that if only one new technique had emerged we would not have coined a new word to describe it. The fact is that a group of techniques has matured fairly recently and, though they have little in common technically, their overall effects have that something-in-common which requires a word to describe it. The word 'automation' as used to describe a group of independent techniques was, in fact, borrowed from the first of them to achieve industrialization. This group is sometimes called 'Detroit automation' or transfer machining. I ought to add that the process is not new and did not originate in Detroit. It applies typically to the operations involved in machining the cylinder block of an automobile engine. These are customarily carried out by a sequence of machining operations effected in automatic machine tools.

The top and bottom of the cylinder block must be planed, milled or broached flat and parallel*. The cylinders must be bored. Valve guides must be drilled and valve seatings bevelled and ground. Bearings for crankshaft and cam shafts must be machined. Various flats for mounting auxiliary equipment must be milled and bolt holes drilled and tapped. Machine tools designed to do these individual operations are expensive and idle time on them is costly. The improvement of these tools beyond the point where they can cut faster than a human operator can set the work up to be machined is obviously uneconomic, for faster machines would spend an undue proportion of their time waiting for work to do.

In 1923 Morris Motors first attempted to tackle the problem of feeding work into and out of machine tools automatically. The experiment was technically but not economically successful. The machine tools of 1923 were not fast or costly enough for the time saved in mechanizing their input and output to pay an adequate dividend on the cost of mechanizing the transfer process.

Twenty years later the Ford Motor Company of Detroit repeated the experiment with altogether different results. This was not because they were cleverer or more persevering than the Morris Motor Co. of 1923, but because

* In the case of a V-engine, the top of the cylinder block will consist of two inclined faces.

the capital costs of machine tools had risen in the interval due to the use of harder cutting tools which could be employed to cut at higher speeds. The technical problem of mechanization was unchanged; the economics of the substitution had changed out of recognition. As so often happens a local nickname was given to the project at Fords. Automation was the name that stuck. From Fords it spread to the rest of the automobile industry and from the automobile industry to industry generally, which uses it to describe a variety of processes having little in common with one another technically. The pressed steel bodies of automobiles are prepared by a sequence of stamping operations, between each of which a partly formed blank has to be handled by human operators. Just as Detroit automation can be quite properly described as transfer machining, so the mechanization of these intermediate handling operations can be described as 'transfer pressing', and the generality of all such substitutions as 'transfer processing'. All may be popularly described as one of the techniques included under the general heading—Automation.

You can readily see that the techniques of 'transfer machining' and 'transfer pressing' involve characteristically different problems. There is little in common between manipulating a rigid object like a cylinder block into very precise register underneath a multiple boring machine and manipulating an awkward floppy object like a large piece of sheet metal into approximate register under a press-tool. Certain strategic problems are however common to both. For example, it is uneconomic to complete a whole sequence of operations and reject the finished work because of a fault due to the first of them. With automatic transfer there must be automatic inspection, involving the twin problems of how to effect it and how often and where to apply it.

Again there is the problem of breakdown. Nothing works perfectly. A tool tip may wear or break. A press die may wear or be damaged. Is a whole sequence or transfer line to become immobilized because of a halt at one single point? If not, it must be broken up into sections at each one of which a buffer stock of partly-finished work must be held. Into how many such sections should such a line be divided and how much work should be stored at each? These sort of problems ought to be a happy hunting ground for the industrial mathematician employing the methods of operational research, theory of games, linear programming and theory of queues.

I feel I have now given a picture of a push-button factory with a river of castings flowing in and a river of finished engines flowing out. Let me however assure you that such a picture is false. Push-button factories are like space-rockets, and push-button manufacture is like space-travel. There are no realizations of such fictional concepts even if industrial journalists cannot resist the temptation to dramatize them in advance of achievement.

May I accordingly introduce you to a simple economic consideration in this field. The terminal phase of any substitutive process such as automation operates under the law of diminishing returns. The first stages to be tackled are those which are either technically easiest or economically most remunerative or those which represent a compromise between the two *desiderata*.

Suppose for instance that a sequence of processes requiring 100 human operators can be transformed into five blocks of twenty sequences each, each sequence being integrated by transfer processing. Ninety-five human operators will be eliminated by this reconstruction. Five will remain, the five required to transfer work between the five blocks. These last five operators will almost certainly be concerned with transfers which would be technically or economically unattractive. It is almost certain that some other process would at this stage compete for the attention of production engineers.

You can now see why push-button factories are science fictional. Machining cylinder blocks was economically rewarding and technically feasible and production engineers accordingly turned their attention to it. They did not however go on to try and assemble complete engines automatically. They diverted their attention elsewhere and tackled the problem of transfer pressing of automobile bodies. Automatic assembly in this field is too difficult to be attempted as yet. For this reason techniques of automation constitute a patch-work within the pattern of general manufacture. For as far ahead as can be foreseen there will be, at most, push-button processes, but not push-button factories.

I have now introduced you to the historically first of the techniques which are grouped together and described as automative. Automation—automative—I regret that those who coined these new terms did not include a philologist. The adjectival form 'automative' provides a useful contrast with the colloquial use of the word 'automatic'; but what of the verbal? Does one 'automate' or 'automatize'? I suggest the following classification of the words involved, though I cannot pretend to any canonical authority for doing so.

	Traditional/Colloquial	*New/Technical*
Verb transitive ...	Automatize	Automate
Adjective	Automatic	Automative
Abstract noun ...	Automatization	Automation

You will remember that I suggested the substitution of nerve and brain rather than muscle and brawn as characterizing automation. In transfer processing nerve is at a minimum and muscle at a maximum compared with the other processes which I will be discussing. Remembering that the easiest processes are those to be tackled first, this contrast is understandable. Do not however forget one criterion which indicates that nerve and brain are involved in Detroit automation: there cannot be automatic transfer without automatic inspection; here lie the elements of nerve and brain involved.

The second great group of techniques to which automation can refer involves automatic assembly. Automatic assembly is not new. You can, if you wish to be pedantic, regard a loom as a device for automatically assembling a piece of cloth. Some would quarrel with so extensive a scope being given to the idea of automatic assembly, but they would certainly agree that it could be applied to the manufacture of electric lamp bulbs, and that such manufacture, though highly automatized, is not new. Lamp bulbs, radio valves and cathode ray tubes—

they followed in that order; but the production of a complete amplifier went so much further that it seemed justifiable to give it a new word and automation was extended to include such production.

The first stage was to fabricate the electrical connection as a separate unit. This was achieved by the technique known as 'printing circuitry'. Essentially, a conducting pattern is laid on an insulating board. There are many ways of doing this. A common, the most usual, method in fact is to lay a copper foil on to a plastic backing plate and to print a pattern on the compact with an etch-resisting ink. The compact is then etched leaving a pattern of copper-foil conductors bonded to the plastic. A variant known as the negative process is used where a conducting pattern is required on both sides of the board and connections have to be made through from one side to the other. According to this variant the plastic board is clad with copper foil on both sides and a negative of the pattern required is printed on each side. Holes are then punched at the points where the connections are required to be made through the plastic from the pattern on one side to the pattern on the other and the whole placed in a copper-plating bath. Copper is deposited on both faces and creeps through the holes from one side to the other, according to a convenient property of copper plated in this way. When the connection is established, the work is transferred to a tin-plating bath and the exposed portions of the copper including the holes are tin plated. The ink used as a resist is then removed and the compact treated with a differential etchant which removes copper but not tin. Like all wet processes of this kind, photographic, photolithographic, electroformative, and so on, printing circuits sounds complex when described verbally. It is quite simple to perform however, and the process does not look complicated when you see it broken down into technical operations which can be observed.

The connecting circuit being established in this way, there remains the problem of assembling the components in register thereon. This is essentially a stapling operation and the unit operation does not differ materially from that used in a very familiar office gadget, the stapling clippers which pin dockets of paper together.

An electrical component, be it resistor or capacitor, is commonly a cylindrical element with two opposed axial leads in tinned copper. These are conveniently mounted on expendable tapes wound on a feed drum, the whole being somewhat reminiscent of the belt feed of bullets to a machine gun. A sequence of such drums is mounted at stapling stations on the assembly line and, as the printed circuits boards are fed in register on a conveyor belt under the various work-stations, feed and stapling action comes into play and each board acquires its complement of circuit elements as it traverses the various work-stations. All components being stapled in register through holes in the printed circuit board, the latter is dipped into a soldering bath and all the stapled connections soldered firmly together in one operation.

The successful achievement of processes as complicated as the foregoing represents a substitution of human eyes and fingers. The component of nerve and brain displaced is greater in proportion to the displacement of muscle and

brawn than in the case of transfer machining. If one may properly be called automation, so may the other on the definition of automation used here. The number and variety of the problems to be solved exceeds that involved in manufacturing lamp bulbs by such a large factor that a qualitatively new feature seems to be genuinely present. Such being the case, the achievement goes further than the mere manufacture of amplifiers for deaf aids, radio receivers and television sets. It is an inspiration to production engineers who will now perforce ask themselves in how many other fields comparable achievements may be awaiting discovery.

In my third example of automation the component of nerve and brain eliminated is greater still. I refer to the whole group of techniques known as control engineering. These are not new, but have undergone remarkable evolutionary acceleration in recent years. Centrifugal governors were first used in corn-grinding machinery. James Watt adapted—and patented—a modification of such centrifugal governors to steam engines. Speed governors, thermostats, auto-pilots: these all belong to a family of devices having certain features in common.

First they all contain some quantitative measuring device which indicates the appropriate quality to be regulated: speed, temperature, direction, and so on. Secondly, they possess a device for 'setting' the regulator by selecting some particular value of, for example, speed, temperature, or direction which is to be maintained constant. Thirdly, they contain a subtractive element which indicates the error between the desired and the actual performance to be regulated. Fourthly, they contain a regulating element operated by the 'error' signal generated as described above in such a way that a correction is introduced adjusting the performance to bring it into conformity with the setting. Thus steam is turned on if velocity is too low or off if too high; a source of heat is turned on if the temperature is too low or off if too high; rudder is applied to the right if the boat, aeroplane, missile, or whatever it may be, is off course to the left and to the left if it is off course to the right. I must now refer to the advances in this field; they are twofold: theoretical and practical.

A characteristic of all these self-regulating or negative feed-back elements is that they 'hunt' or oscillate about the desired setting. In certain circumstances this hunting may be dangerous. The unskilful driver of a motor car can be regarded as an unstable control element; the car yaws to left and right of its course. Those who can sail a boat will be aware that it is much more difficult to sail a boat skilfully into a variable wind than to drive a car along a twisting road. The sailing boat has two settings, that of the sheets and that of the tiller and they interact in such a way that a course into the wind easily degenerates into a series of cusps, in which the boat comes too close to the wind and loses way before paying off. Automatic regulation by means of two interacting controls is more difficult to stabilize than regulation by means of a single control. An example of instability is provided by the yawing of a towed vehicle such as a trailer caravan. If well designed, the system (vehicle/tow-bar-linkage/trailer) should be stable and the trailer should follow the vehicle faithfully. At critical

speeds, however, a trailer may commence to yaw and the amplitude of this oscillation may build up to the point where a disaster occurs and the trailer overturns. Imagine that instead of the direction of a trailer we were concerned with the neutron flux in an atomic reactor, or the plate hold up in the fractionating column of a big oil refinery, and you will see how very disastrous instability can be. Necessity is the mother of invention. Guided missiles with their multiple controls, oil refineries with their multiple feed backs and atomic reactors with their potentially high-speed response to divergent conditions have, of recent years, presented problems bristling with intractable mathematics and a method of solving them has had to be evolved. This involves building electronic models of the systems involved, models which, in essence, are describable by the same intractable mathematics as the original systems. The behaviour of these models then provides an alternative to the numerical solution of the mathematics. Models of this kind are known as analogue computers and their evolution and successful construction and study have led to notable advances in the theory of the subject.

The practical side has been associated with the development of electronics. May I present two alternative uses of an electrical assembly. It can be thought of as a source of signals, or it can be thought of as a source of power. In automatic control we are concerned with both. Physical conditions of heat or light, temperature, pressure, stress, torque, and so on, can all be made to generate electrical signals. These usually take the form of small voltage changes at a low power level across a load resistance. These signals require in general to be processed as input signals and delivered as output signals after processing. By processing I mean that some sort of a signal or pattern of signals 'in' has to be converted into some other sort of signal or pattern of signals 'out'. The output signals have finally to be amplified in such a way as to generate power in quantities sufficient to work regulators. Electronics enters into this operation in two ways. Firstly, the electronic amplifier is usually an essential stage in the output process of raising the power level of a signal to the point where a regulator can be brought into action. Just as important, however, as power amplification is the use of electronic circuitry for the processing of signals, that is of converting one pattern into some other pattern. One can see the importance of this in an intuitive way, but why is electronics important as a means to the end? The reason is a simple one, though it is not usually given in the form in which I prefer to see it stated. Electronics permits a divorce of functional from spatial distribution of component elements that is without precedent in mechanical terms. In any mechanical assembly function and geometry are inextricably linked. A wheel must rotate about its geometrical centre, a lever about its geometrical fulcrum; the teeth on a gear wheel must not only have number but precise configuration in space; a shaft cannot be bent round a corner without four bearings and two crown wheels; parts which are functionally sequential must be spatially contiguous; and so on. The designer of a mechanical information processing device of more than a limited degree of complexity is thus beset with the difficulties inseparable from the fact that two pieces of matter cannot be in the same place at the same

time. What he finally designs, as in cam-operated predictor equipment, has to be fabricated with extreme precision. In the electronic counterpart of any such device all these difficulties disappear, permitting an increase in the complexity of the devices which can be fabricated for the same design and development effort. It is true that other difficulties arise to replace them; for example, a metallic part remains the same size throughout its history, whereas electronic components drift in value, or tend to. But these difficulties do not affect permissible complexity directly so much as a certain kind of reliability, namely the number of occasions when a part requires to be replaced. This, of course, may have an indirect effect on complexity in so far as the latter may entail a physical multiplication of essential units. These must not be multiplied to the point where at least one is always out of action. Fortunately this limitation is not encountered until after electronics has accomplished a notable advance on any signal processing device achievable without prohibitive complexity or expense by mechanical means.

I feel that these descriptions are somewhat abstract and that a concrete illustration of an automatic control system would be appreciated. In this context I would invite consideration of the operation of a big modern oil refinery. There you will find chemical and thermal feed-back loops of a complexity such that no man could visualize the effect of his intervention *seriatim* at all the control points without being thrown into a state of mental confusion. All these points will be found to be under the control of automatic regulators linked and coupled in such a way that human intervention is largely unnecessary. The result, you will find, is stable. Stripping columns do not surge. Only a small handful of skilled operators will ever be found engaged in working the plant. For the most part, though they are conventionally referred to as 'labour', they have little to do except wait for something to happen which requires personal intervention. The handful who operate the plant are outnumbered many times by the skilled fitters and engineers who maintain it and replace corroded or mechanically worn parts. Labour in the classical sense has simply disappeared. There is no unskill; it is all skill.

May I now turn to the fourth and last group of techniques included under the name of automation: information processing techniques made possible by the achievement of the electronic digital computer. The component of brain and nerve replaced is here at its maximum relative to the displacement of muscle and brawn. In contrast to the techniques of automatic control which commence with information and end with power-operated servos, data processing or information handling starts and ends with information. There is no final stage of power amplification. Automation in this context provides a partial substitute for the brain of the accountant. For this reason electronic computers are sometimes called mechanical brains. If you care to call a mechanized grab a mechanical hand, you are of course free to do so, if you consider it appropriate on the grounds that it does work for which a hand would otherwise be required. By the same token you can call an electronic computer an electronic brain if you think it appropriate for a cognate reason. Only be clear that they are not brains, are not

alive, do not think and are merely the faithful slaves of human beings who are alive and do think. They can do simple tasks such as calculating that 'one and one make two' very much faster than a human brain. Complicated tasks such as translating '*Bon jour*' into 'Good morning' take them much longer than a human bi-linguist would take.

If there is any analogy at all between a computer and a human brain it must subsist between one brain and a battery of some ten thousand computers. The discrepancy is as large as that. Physically I cannot hope to describe these instruments in the space available as part only of one paper. They can be visualized as part clock, part gramophone or tape record, part automatic telephone exchange, and part the counting half of a Geiger counter. This is achieved by employing some multiples of thousands of electronic elements disappointingly packaged as breadboard assemblies in regular arrays like guardsmen on parade. They are impossible to 'take in at a view' as there is nothing to see working except an automatic typewriter. One has to take it on trust that the computer rather than some other agency is actually working the typewriter.

The immense difficulties that were overcome in the construction of the earlier computers had a comical component brought about by the limited analogy between the computer and the brain of its designer. Facetious treatment of these analogies was temporarily good copy for daily journalism and for a while the earlier computers had news value accordingly. This phase has passed and computers can now be seen as powerful auxiliaries in mathematical laboratories and accounting houses, but little more. They will not replace the human brain except on routine work—the routine of costing, pay roll calculations, or stock records on the one hand; the routine of the numerical analyst on the other. No mathematical calculation can be performed on a computer which cannot be performed with pencil and paper. But some, in fact many, calculations which would take prohibitively long with pencil and paper can be completed economically with a computer. In fact, one can go further and say that no calculation can be done with a computer *unless* it can be done with pencil and paper.

It would be beyond the scope of this paper to describe the application of computers to mechanized accountancy. Suffice it that the accounts department of 25 years hence will be different in many respects from the same department to-day.

I have presented to you four techniques properly denotable as 'automation'. I would not have you imagine, however, that because they are technically independent of one another they do not, in their applications, interact. Transfer machining, as I have said, entails automatic inspection. It entails more than that however, for the system must react appropriately to the results of the inspection and that involves an element of automatic control. As transfer processing increasingly dominates every branch of mass production, so will the solution of automatic assembly problems become ever more pre-emptive as the logical consequence of trying to integrate the push-button processes into a push-button factory. Moreover, automatic assembly processes in the electronic field themselves appear likely to be the clue to the problem of cheapening computer

production and bringing the computer into a price range where it will command wider economic utility.

Finally what are we to make of the computer-controlled machine tool? Such devices produce accurately machined parts on instructions fed to a computer on punched tape or cards, the computer being linked to the tool by appropriate monitors and servos. At least two components of automation, data processing and automatic control, enter here as equal partners, not on a basis of one being a mere auxiliary of the other. Indeed, one may suspect that the germs of all four elements are latent in so novel a device.

Having thus described the four components of automation, their community of function, their technical independence, and their interaction in application, may I conclude with the definition to which the foregoing will serve as a preamble, a preamble which will serve to make the definition both necessary and sufficient:

> 'Automation refers to a contemporary group of independent advances in the field of mechanization. These advances characteristically employ discriminatory devices and automatic controls. Typical subjects classified as automative include transfer machining, automatic assembly, the whole field of control engineering and that part of communication engineering concerned with data processing, accountancy and calculation involving the use of electronic digital computers'.

Such is the reality behind the verbal fad.

DISCUSSION

THE CHAIRMAN: Thank you, Lord Halsbury, for a most illuminating and lucid paper. A paper which I am sure has been fascinating even to those of us who are neither technologists nor technicians.

MR. A. ENTICKNAP: Would Lord Halsbury tell us by what means the typewriter converts symbols of the alphabet to the tape?

THE LECTURER: Regard the teleprinter as both a coding (hole punching) and decoding (hole interpreting) device. Then both aspects of the device, coding and decoding, work as the same code, so that if you turn the letter K into a pattern of holes at the printing stage, the pattern will be turned *back* into the letter K at the receiving or interpreting end.

As to the code itself, the tape has room for up to five holes punched transversely to its length. Each space where a hole can be punched can therefore exist in either of two states after the punching operation: 'hole' or 'no hole'. There are accordingly 2^5 or 32 combinations of holes which can be made to code any one of 32 alphanumeric symbols, or 31 if you exclude a blank strip with no holes in it. If two of them are equivalent to depressing and releasing the capital key in a typewriter then the code can represent $2\ (31-2) = 58$ symbols.

MR. H. A. WARREN: I am fascinated by the idea that Lord Halsbury has put up that the sober, standardized dullness of mass production can in some way be relieved by production scheduling using electronic computers. Would he please amplify that statement. Is there any limit to it? Exactly why is such production scheduling capable of achieving greater variety than human methods?

THE LECTURER: There are certain things that can be done to a product which give it an outward and visible odour of sanctity by allowing you to feel that you have had

some variety of choice. For instance, you can argue that it is not an interference with production to change the colour of the paint in the paint shop. It only means emptying one tin of paint rather than another into a spray gun. You can then have cars of as many different colours as you like. Let us suppose there are five colours to choose from, and also that it does not add to production costs to have five different colours of upholstery. Twenty-five inter-combinations of colour of car and upholstery are now possible. Supposing you go a little bit further and say, 'Let us have the car in two different colours; we will have the top half a different colour from the bottom half'; suppose you again stick to five colours, then you get 125 different inter-combinations of top half, bottom half, and upholstery. Suppose you divide the car up into heraldic quarterings and consider the front half and the back half as candidates for different colours so that the top-front, top-back, bottom-front and bottom-back can be varied; you are now up to 625 inter-combinations. The customer can accordingly go through the catalogue and order a car which is one of 625 things which look different but are, in fact, the same. The manufacturer therefore has to solve the problem of turning these combinations out when they are wanted.

There is no difficulty provided that all the bits that have to meet and match on the assembly line get there at the same time. That means that they have all got to be launched at the same time and that somebody has got to work out in his head exactly when they ought to be launched. Working it out in one's head is one of the things that is not done very well that way, and is done much better with a computer. It would take far too long with pencil and paper.

The problem first became urgent in the air-frame industry where no two aeroplanes are really quite the same. One talks of going for a ride in a D.C. 6, but if you go and talk to Douglas's who make the D.C. 6, you will soon learn that a D.C. 6 for United and a D.C. 6 for Capital Airlines are slightly different; and a D.C. 6 for a United Fleet liner and a D.C. 6 for the Miami run are slightly different, and so on. When you are dealing with things as large as D.C. 6's you cannot make a mistake in which the wrong kind of wing arrives to match up with the fuselage, because it is too big to be put anywhere. If the side panels of a motor car arrive in the wrong order you can probably stack them somewhere until the right ones arrive; and even so, things might get very congested. But if you make four-engined passenger planes, and if some piece arrives in the wrong order, you stop the entire works until you have got the tangle straight again, especially if planes are flowing out at the rate of one a day. This means that everything has to be launched at the rate of one a day in the right order.

This problem is economically very important to the air-frame people and they are solving it; and because they are solving it the automative people are looking up and taking notice that they too have a similar problem to solve. Pressed metal work will be subject to the same sort of consideration. Consider the highly decorative and gay modern-style American kitchen which is now made in many colours and materials; in enamel or stainless steel; in pastel shades of blue, grey, white, pink and what have you. You really can order the kitchen you want and it looks like nobody else's kitchen by the time you have finished choosing it.

MR. A. J. S. SHEWAN: Would the lecturer consider it correct to describe such industries as the chemical-processing and manufacturing and the electric-power generating, which for a long time have used a large degree of automatic and remote panel control, and also for a very long time have used very few humans in relation to the work done, as automated industries?

THE LECTURER: Nothing ever has a real beginning. You are perfectly right in saying that the combustion industries and the oil industries have a long prior history of automatic regulation of one kind or another, just as the steam engine had; it had its Watt governor 175 years ago. I think you could call it automative, but personally

I should not. I would be inclined to reserve the word automative for new processes introduced into these industries rather than describe them as having been automated from the beginning. It is not a very satisfactory verbal state of affairs. Automation as I have discussed it this afternoon means advanced mechanization. Of course, the electrical industry has always been advanced, because it is the child of the laboratory. If it makes anybody happier to say that we have had automation in the boiler room for the last thirty years by all means let them say it. In fact, it might politically be rather a good thing to persuade people that when we say that we automate something we are rather like the 'bourgeois gentleman', who discovered that he had been talking prose all his life without knowing it.

THE CHAIRMAN: Would it be correct, Lord Halsbury, to say, as I think it has been suggested in some quarters, that the difference between mechanization and automation is that the latter is self-controlling and the former is not?

THE LECTURER: There again one gets into a difficulty; nothing is 100 per cent self-controlling, though it may be nought per cent self-controlling. I would not like to say of any process that it is 100 per cent self-controlling because it is usually arranged to decouple the control and hand over to human operators in case of need.

An example may illustrate the difficulties of definition. Consider a polythene plant which polymerizes very high pressure ethylene. The high-pressure ethylene is extremely liable to detonate. If the temperature starts rising, nothing you can do will stop it rising further and eventually the reaction detonates. No automatic control can respond nearly fast enough to control it; the plant is therefore designed so that when it detonates nothing happens. You put a pipe on the top of the plant and you seal this pipe with a rather thin metal plate; when the reaction detonates this plate bursts but nothing else does. You build a chimney round the plate and detonation blows what is left of the plate up to the top of the chimney, when it falls back again. A number of automatic controls then go into operation and shut the plant down; it is then in the hands of the human operators. Thus it goes over at intervals, by virtue of detonation, from what is almost 100 per cent automatic control to what is nought per cent automatic control. I do not know how one would bring that into the definition.

I think the way one should look on all these matters is in terms of trends. The trend of automative devices is to more and more completely independent control. This, incidentally, involves a human problem, because if the failure of anything automatic would be dangerous to the neighbourhood you have got to have human operators standing by; this is obviously so with nuclear energy piles. It would alarm the district to feel there was nobody standing by. The problem, then, is what to give them to do, because it is demoralizing for a man to sit and wait for something to happen. By the law of natural cussedness he is always asleep when something does happen; it is just one of those things! So what has been found necessary in some plants is to de-automate the plant in order to give human standby operators something to do.

MR. F. R. W. STRAFFORD: I have had endless arguments with my colleagues as to what is the difference between mechanization and automation. An automatic lathe or a multi-spindle drill is a device which offers an example of mechanization, but it is unable to control its wear. Parts can go out of limit and then an inspector stops the machine and something is done. In the case of automation I suggest that, whether it is done mechanically as in the case of centrifugal governor, or whether it is done electronically, there is a sensing or checking or automatic inspection device associated with it. I would be inclined to define automation as a mechanization process which includes a very large measure of self inspection.

I think a digital computer system would have been very useful to the production

expert who put lighthouses on a belt system. After producing 6,000 he found he had not put the reflectors inside!

THE LECTURER: If you remember, after I had given my definition, I said, 'that is the reality behind the verbal fad'. Of course, there is a lot of verbal fadding in automation and how to define it. One's reaction to these matters must in some way depend upon whether one is speaking as a technologist or a politician. As a technologist I think that you will find that the definition I have given includes anything that you are likely to want to include. It includes the historical origin and it does not exclude anything which ought not to be excluded. Of course, I speak as a technologist. I cannot speak as a politician because I am not one, but I understand from enquiries which I have made of my friends that from the political point of view automation has been defined as anything which somebody chooses to call automation. I come here in my innocence this afternoon as a mere technologist and I cannot deal with what people want to call automation for political purposes.

I would have thought the last speaker's example fell within the definition. If anybody wants to say, 'This machine is automated because it has a feed-back loop which is of the self-healing kind', they are free to do so. I think that in terms of the definition I have given they certainly may. But the moment you start making any one criterion a basis for definition you find yourself in difficulties by excluding something else which, by common usage, is included under the heading of automation.

If, for example, you use the idea of self-checking then some computers are not self-checking—in fact, no computer is at every point. I do not know that an automatic regulator is self-checking. What you try and arrange always is that it fails at safety. I do not think that automatic assembly of printed circuits is self-checking. So if you use self-checking as a sole criterion you exclude some, or all, of the aspects of at least three of the main divisions of the subject. For this reason no single criterion can be used. In fact, as I said at the start, we are dealing with essentially independent techniques. What they have in common is that they represent the advanced mechanization which happens to have matured now in the mid-twentieth century. If it makes anybody happier to call it automation let them so call it.

MR. G. A. S. NAIRN: The speaker touched on the subject of redundancy arising out of automation or other methods of increasing production. One reads so much in the public press to-day of the need for joint consultation in the development of such plans. Has he any views on this? Does he agree, for example, that many of the problems which seem to arise might be overcome if organized labour, which has been described as one of the two partners in industry, the other being capital, could be brought into consultation in the early days and have explained to it, in words of two syllables, just exactly what is being attempted or planned in order to improve the economic stability of this country?

THE LECTURER: I speak as a technologist and my function is to tell both sides what the facts are. If they misinterpret the facts for one reason or another, that is not my business. I believe that the political classes and the employing classes, and organized labour, are all in a position to ascertain the facts from willing informants if they care to do so. If for political or other reasons they would sooner have the subject in a state of confusion in order to exploit the difficulties that confusion causes, I do not think there is anything that the technologist can do about that situation. All that the scientists and the technologists can do is to decline to take sides in fictitious disputes and say 'These are the facts; it is up to you to make the right use of them'.

MR. L. LANDON GOODMAN: It is essential that engineers and technologists shall be concerned with the ethical considerations of their work. It is only they who can visualize the full implications for society of their work. Also, if they do not study and explain to the layman the impact of their activities—as nature abhors a vacuum—

others will try to fill the void, others who cannot possibly have the required knowledge. We have seen something of this in the recent outburst in the press and other places where some people who have written and spoken on automation appear to have done so mainly with the idea of furthering a particular partisan policy.

In a paper which I gave to the Royal Society of Arts on 'Materials Handling and Processing, Past and Present' in 1953, automation was defined on page 687, vol. CI, as 'the complete automatic and selective transfer of a part from one process operation to another'. In my address I said that the word 'automation' had been coined by D. S. Harder, now Executive Vice President of the Ford Motor Company of America, in 1947. It only came out in correspondence with Mr. Harder the other day that he first used the word automation in 1936 when he was with the General Motor Company of America. He has now modified his definition to include the impact of handling upon processing.

MR. H. S. HULL: I would like to ask an exonomic question. Where do we start? With how small a factory and what line of production can I safely introduce a transfer machine? It is possible to get the cost of the transfer machine, but can we get the real costs on the electronic side of it? What is it going to mean and what is the labour aspect of that side of the business?

THE LECTURER: The problem of costing the utility of a computer is a very difficult one. If you assume that you buy a computer for one purpose only, say to do your wages, and you buy a biggish computer for the purpose, you will require to do the wages for about 4,000 people in order to break even. But assuming you work a five-day week, your computer will do nothing 4¾ days out of five. Now supposing that you can find four or five other jobs each about the size of the wages job, such as inventory control, cost accounts, customer invoicing, and so on, you will be breaking even on a factory of about 800 people instead of 4,000, and your computer will be idle for only about 3¾ of your five-day week.

Supposing next that you also run a design and research department and book out time on the computer at its economic cost as research; suppose further that half the computer-time is thus booked for design and research purposes, then you will break level with a factory of about 400 people.

The problem is one of saturating the machine with work. You will almost certainly end by keeping it much busier than at first. It is therefore extremely difficult to give chapter and verse as to the size of establishment in which a computer becomes economic.

As to transfer processes, I think it is probably agreed that unless you are making something like motor cars, or sewing machines, or vacuum cleaners, or refrigerators, or any of the things that sell in quantities in excess of 100,000 or more a year, then transfer processing may not pay. But, of course, you must consider cost and throughput in conjunction with another. If you go to Fords at Detroit you will see that the Lincoln engine and the Ford engine are made by two quite different processes.

The faces on the cylinder blocks of Ford engines are machined in one gigantic broaching operation. The broaching tool is enormous; it just passes once across the face of the cylinder block and the job is finished. That pays assuming a throughput of 6,000 engines a day. But Fords are still milling the cylinder faces of the Lincoln engine with a throughput of only 200 engines a day. A throughput of 6,000 a day justifies a big broach and a throughput of 200 a day does not. So I cannot answer your question in precise terms. It is necessary for your accountants to study the matter in association with your engineers.

MR. J. O. MAYER: It did seem to me that the lecturer treated rather lightly an earlier question on the subject of inspection. Lord Halsbury said inspection could probably

be divided into five stages, with a check at each stage as to whether the machine were doing the right thing.

On all the programme-controlled machine tools of which I have had experience there is no work-piece inspection at all. There may be the self-healing feed-back loop which was described, which tells whether the machine components (the moving parts of the machine) have done what the message told them to do, but there is nothing to tell whether the component is coming out the way the drawing shows it should. Therefore this is not inspecting, but checking on the controlled motions. Would the lecturer agree?

THE LECTURER: That is perfectly true. Let us suppose that you are machining a cylinder. You assume that if there is no wear on the tool tip, and if the monitor shows that the tool has moved through a certain distance, then it has in fact moved through that distance. You, of course, have got to check that at intervals. The whole purpose of these computer-controlled machine tools is to get rid of the gap between production techniques which will produce a million off cheaply, and production techniques which will turn off 10 or 100, or 1,000 very expensively. If you want a million of something off you know what to do about it; you tool up to produce a million and the experienced production engineer and the accountant can tell you how to do that with the minimum overall cost. But if you want 100 of something off, you have got to get a skilled operative to make each one of those 100 individually. If you can make a computer-controlled machine tool do that, you have tooled up in a different kind of way. You have tooled up with a general-purpose machine as opposed to a special-purpose machine.

MR. MAYER: Can you tell me how you do measure the wear on a tool tip? As I see it you only measure the movement of the carriage which carries the tool.

If you speak of measuring the position of the tool tip, which has been done in simple turning operations by measuring the work-piece diameter, you are introducing another theme, 'Inspection at the Machine', which is not yet a part of the computer-controlled machine tool.

Take any of the tape-controlled systems which feed messages to motors: they do not check whether the tool is getting smaller, or the cutting edge is getting rounded and is cutting less material. Do you have knowledge of any system which does?

THE LECTURER: With respect, you are getting two subjects confused with one another. A computer-controlled machine tool merely replaces the human operative who turns out skilled work at a very high cost. That human operative has himself got to measure the work that he is doing and ascertain that he has turned out what his blue print has told him to turn out. He himself has not got to find out whether his tool is wearing or whatever may be going wrong with it. You can automatically bring a tool up to some point at the beginning of an operation and then bring it up to the same point half way through the operation and find out if the point has changed.

It is no criticism of the computer-controlled machine tool to say that it does not do something it does not set out to do. If you want a computer-controlled machine to bore a hole you have still got to have an air gauge or something similar to tell you that it has done it right. The point is that it will bore a more complicated hole with less tooling for much less cost than you can bore by any other method; but you have still got to measure what you have done. All the computer-controlled machine tool does is to monitor the carriage movement as it goes along.

MR. C. R. PRYOR: Lord Halsbury, in his definition of automation, referred to digital computers. That by implication excluded logical and analogue computers. Was that intentional and if so, why?

THE LECTURER: Not logical computers, because they are in general digital (they work with Boolean algebra which requires the digits nought and one in which to

express its results). You will find that it is in the field of control engineering that analogue computers and simulators are mostly used. My definition reads 'the whole field of control engineering' (that includes analogue computers) 'and that part of communication engineering (only a part, we are not concerned with telephones) concerned with data processing, accountancy and calculation involving the use of the electronic digital computer'.

DR. B. BARD: It is clear from Lord Halsbury's address that there is not going to be a new species of engineer called the automation engineer or automative engineer, but it is also clear that a very large number of technologists of various kinds are going to be required in the future for the introduction of these new techniques. Could the lecturer perhaps say a word about the types which are likely to be in short supply and thereby constitute a bottleneck in the introduction of automation into industry?

THE LECTURER: I think the bottlenecks will be caused by those who do not know much about the subject. I think one needs to discriminate between an engineer in the technical sense and an engineer in the professional sense: that is someone trained and accepted by the corpus of professional engineers as one of themselves. An automation engineer will, in fact, from the professional point of view, be either a mechanical engineer, or an electrical engineer. He would have to know all that either the one or the other knows to start with, in order to call himself an engineer at all. But, of course, a mechanical engineer who works on automatic packing machines, let us say, soon becomes an expert on automatic packing machines and begins to lose his interest in other subjects in which he could have specialized when he was freshly qualified. The same will be true of the electrical engineer. He may specialize and go into the communication field, or he may go into the power field, but he will still have needed to qualify as a professional engineer by knowing all the basic science that is common to both.

I do not think there will be a new type of engineer, called an automation engineer, in the professional sense; but I think there will be a new type of specialist called an automation engineer who will probably belong to a specialist society catering for his interests but not acting as an examining body.

LORD SEMPILL: It is a great pleasure to be invited to try and express in a few words our appreciation of Lord Halsbury's paper. The very fact that the lecturer has a fine record of achievement in the scientific and technological fields led us to expect something out of the ordinary and not some ill-considered addition to the many expressions that have been made by others. If I may say so, my lord chairman, we are grateful to you for the thoughtful foundation of your opening remarks on which the noble lecturer was able to build.

As a nation we cannot afford to lose any opportunity for increasing productivity, and it is unfortunate that certain interests are striving to use a scientific and technological process to advance some political argument, and to do this are often speaking in terms of exaggeration. It is of great importance that the economic aspects that the introduction of automation will bring about should be considered carefully, since understanding of these in advance will ease the way to the introduction of this new technology by explaining just what it will mean.

To-day we regard the computer as a necessary mechanism in factory and office, but it would be well to remember that it is an invention of 100 years ago that required two other inventions before the concept of the Cambridge mathematician, Babbage, could be given the effect of to-day.

On your behalf I have very much pleasure in thanking Lord Halsbury for a thoughtful and informative address on a sub-species that, properly used, can bring great benefits to our future.

A vote of thanks to the Lecturer was carried with acclamation, and the meeting then ended.

THE THIRD EVENING DISCUSSION MEETING

THE USE OF LEISURE

The third and last evening discussion meeting of this Session was held on Wednesday, 28th March, the subject for discussion being introduced by Dr. Stanley Gooding. The meeting was presided over by Mr. A. R. N. Roberts, a Member of Council of the Society.

Dr. Gooding began by pointing out that leisure was clearly not a state of doing nothing, and was not necessarily synonymous with relaxation. There were people to whom work was all absorbing, and who had no leisure. Napoleon, for instance, had to withdraw into himself for an hour during the day to refresh himself, and Mozart was similar in this respect. That would be called relaxation, but not leisure. Leisure might be described as a restful change from one's usual occupation. In every age, people employed their leisure differently. In these days of mechanization and automation it might be thought that there would be more free time, because the machines did the work. That did not seem to be so, however. A great many men to-day had to help with household chores, owing to the lack of domestic help.

In the past, while the ladies were engaged in such pursuits as embroidery, men, according to Galsworthy, talked. The art of conversation, in fact, flourished, and was practised in the clubs and at the dinner table. That art seemed now to have been lost, and with it the power of people to amuse themselves. Leisure, to be enjoyed, must be satisfying and must involve the expression of the personality. That could not be done at the cinema, or by watching the television screen. A friend of Dr. Gooding's spent his leisure in watching the unfolding of nature. That involved study, in order that the maximum pleasure might be derived from the observations. This, however, did not imply that detailed knowledge was essential for the use of leisure. It was, in fact, regrettable that in these days of specialization one was expected to express views only on subjects in which one had specialized knowledge.

Neither should physical recreation—sport and physical culture—be forgotten. They were real relaxation and provided a complete change for the man who worked with his brain.

The problem of leisure was becoming particularly important now that men were retiring earlier. If they had no interest to take the place of work after retirement they were lost. That time should be prepared for in advance, so that full-time leisure might be adequately employed.

In the general discussion which followed, the definition of leisure which had been given was questioned. It was suggested that it was not necessary to be actively doing something in order usefully to employ one's free time. As an illustration, the person who listened to music critically was compared with one who simply sat back and enjoyed it.

Leisure, it was proposed, was the opposite of one's normal occupation, and

involved doing exactly as one liked. It need not necessarily be a restful change, but it was free time as such. The way it was employed fell into three categories—doing something oneself; watching other people do it, or doing nothing at all. The way one used one's leisure was very much bound up with personal intellectual standards, natural ability, inclination and temperament.

The satisfaction to be gained by the office worker from doing things with his hands was also mentioned, but this, it was suggested, did not exclude other ways of occupying leisure time on other occasions. Anything which one really liked doing was a fitting occupation for leisure time and was recreation. It was further suggested that a wide variety of interests was most important.

The great difficulty in saying what constituted a satisfactory use of leisure was stressed. It was suggested that the normal human being required physical, mental and moral relaxation. A specialized job, for example, required something to offset it and restore a sense of balance. Each individual must know what was most satisfying to himself, not with the object of making a contribution to the community at large, but of making himself happy and contented, although a full and contented life for the individual would inevitably result in a more stable and happy community.

The view was put forward that there were two distinct ways in which leisure might be occupied: either one did something definite, which resulted in a feeling of satisfaction, or the time was spent in pure relaxation. The idea that the individual ought to be able to express his personality in order to achieve a satisfactory use of leisure was questioned. There was much to be said for the man who could appreciate another's skill, and that was what we were doing when we went to the cinema, the theatre or a football match. The artist, musician, or any other skilled performer derived a great deal of satisfaction from his own work, but this was considerably increased if he felt that others were appreciating it also. In defence of those who enjoyed watching television, reading for pleasure was cited and it was asked whether the printing press might not have been regarded as a toy when it first appeared just as television was regarded by some people to-day. Like books, television and radio were only another means of communication. The stimulus to conversation provided by an interesting film was mentioned.

The greater strain and pace of life to-day led to less inclination than was apparent in the past to spend leisure in self education, although in this connection the great popularity of evening classes in many subjects was opposed to this view. The increase in leisure time as compared with Victorian days was mentioned, and in this connection the increased speed of communication was cited. A journey to town was no longer the undertaking it was in the last century, and this in itself tended to reduce the stimulus among small groups to provide their own entertainment.

Among those who took part in the discussion were Mr. Hamid Ali, Miss Betty K. Battersby, Sir Frank Brown, Mr. A. C. Chappelow, Miss H. B. Cuthbertson, Mr. A. Freedman, Brigadier J. L. P. Macnair, Sir Gordon Russell and Mr. Arnold Whittick.

GENERAL NOTES

SOME LONDON EXHIBITIONS

Few other capitals can have rivalled London in recent weeks in the profusion of its art. Several current exhibitions have already been discussed here, but as many more of consequence remain on view, and deserve attention; none more than an assemblage of Rodin bronzes cast since the sculptor's death. Though barely forty years divide us from his lifetime, Rodin already appears as remote as a burgher of Calais. No London gallery has attempted more strenuously to quicken interest in him than Roland, Browse, and Delbanco's; and, once again there, his heroic figures, dancers, and other bronze studies impress us as at once fluid and monumental, studious and energetic. Over them all broods *Le Penseur*, ruminating, it might seem, on the inconstancy of æsthetic taste.

Le Petit Village, *by Henri Joseph Harpignies*

The revival of interest here in the Barbizon School is due, in large measure, to another little private gallery, the Hazlitt in Ryder Street. A conspicuous feature of its present exhibition of Barbizon paintings is a group of ten landscapes by Daubigny, and as many more by Theodore Rousseau. Daubigny is represented by works done in his most fertile period between 1862 and 1874, including a magnificently robust painting of sea and rocks under a cloudy sky, *Taliferme en Bretagne*, and Rousseau by his earlier landscape sketches when Constable's influence is most apparent. Rousseau's little *Paysage*, only four inches high, which comes so very close to Constable's earlier style, is marred only by a certain insensitivity in the sky. For the rest, there are two small Corots—an entrancing early one of the Château d'Arques, near Dieppe, and another painted at Rotterdam during his visit there in 1854—together with landscapes by his able pupil Chintreuil, and others by Harpignies, Diaz, and indeed most painters of that pastoral group, with the notable exception of Millet.

To turn from these nineteenth-century works, which as yet only foreshadow the radiant discoveries of the Impressionists, to the paintings of Nicolas de Staël, a prodigy in an age of ceaseless experiment, requires a considerable mental adjustment. It is an adjustment only worth making, of course, if one recognizes that to enter the world of a questing artist may sometimes be as rewarding as mastering a foreign tongue, and discovering fresh vistas for the mind to explore. De Staël, a Russian aristocrat of the School of Paris who died last year, is in truth so exhilarating an explorer that he is captivating many visitors to the Whitechapel Gallery who previously owned to little or no experience of modern art.

Moreover, the painter was a singularly engaging figure, romantic in appearance, with features at once humorous and hypersensitive; and when, to his personal charm, are added the fascination of his years of poverty and obscurity succeeded by a swiftly rising fame from which he chose to deliver himself by his own hand at the age of 41, it will be understood that de Staël has become a legend not soon likely to be forgotten in the world of art. More important, his paintings survive. From a large collection of his work recently shown in Paris at the Musée National d'Art Moderne, the present retrospective show at Whitechapel has been chosen.

Beginning with figurative painting, he turned during the last war to dynamic linear designs, which in turn developed into calmer, more spacious abstractions, in which *briquettes* of pigment may have the succulent quality of whipped cream. All the while de Staël was making numerous glowing colour notes, and noting the vibration of tones; and with this science he now embarked on a series of simplified figures in brilliant primary colours, more intensely luminous than the *Fauves*'. His last phase of summary, and strangely illusory, representation of natural scenes and still-life, is perhaps the most exciting. All the Mediterranean seems distilled in the broad washes of colour swept in with feathery strokes in *Marine*, and the beat of wings is made palpable in *Seagulls*, inspired by his reading Tchekhov to his daughter Anne. A complex and dazzling figure.

NEVILE WALLIS

PUBLIC HEALTH COMPETITIONS

The Council of the Royal Society for the Promotion of Health announces that prizes ranging from 50 guineas to 10 guineas are offered this year in essay competitions on the following subjects: The Planning, Layout and Administration of a Large Caravan Site; The Advantages and Disadvantages of Amalgamation between the Health and Welfare Services of a Local Authority; The Ideal Training for a Nursery Nurse.

The closing date for entries is 31st December, 1956; full particulars of conditions of entry can be obtained from the Secretary, Royal Society for the Promotion of Health, 90 Buckingham Palace Road, London, S.W.1.

BRITISH DESIGN EXHIBITIONS IN SWEDEN

During the State Visit of Her Majesty The Queen and His Royal Highness The Duke of Edinburgh to Sweden this month, British weeks are being held throughout Sweden. These include displays of British goods in the shops, and as a focal point a selective display of well-designed British goods is on view in the Kungstradgarden, a Stockholm park. This Exhibition has been staged jointly by the Council of Industrial Design and the Svenska Slöjdföreningen (the Swedish Society of Industrial Design), who have twenty permanent showcases, lit at night, in the Kungstradgarden. The majority of the exhibits have been selected by Dr. Åke Huldt, Director of the Svenska Slöjdföreningen, from the opening display at the Design Centre. The Exhibition is on view in Stockholm until 15th June, and will reopen later in the summer in Gothenburg.

Another interesting exhibition is that of design from the Royal College of Art, in which the Society's gavel is included on loan. The exhibition at Föreningen Hantverket, Stockholm, is open until 14th June.

CORRESPONDENCE

EXPENDITURE ON GAMBLING

From H. C. HAYCRAFT, ESQ., THE FORGE COTTAGE, BISHOPSBOURNE, CANTERBURY, KENT.

I notice on page 482 of the *Journal* for 11th May, a statement in relation to gambling which really should not be allowed to pass without amendment. The figures given for money spent on gambling in 1954, totalling £550 million, are in fact the figures for *turnover*, which is approximately ten times the amount 'spent' or 'lost'. The Royal Commission on Betting, Lotteries and Gaming (1949–1951) reported that the 'personal expenditure in 1949 on all forms of gambling totalled £70 million'. (This compares with £764 million as the 'personal expenditure' on tobacco.) But as £26 million was taken in taxation, and served to augment the general revenue, the 'national cost' (i.e. the money actually wasted in gambling) was no more than £44 million. This is not much more than one tenth of our public expenditure on education.

SHORT NOTES ON BOOKS

ENGLISH FURNITURE STYLES FROM 1500 TO 1830. *By Ralph Fastnedge. Penguin,* 1955. 5*s*

Recent developments in the study of the history of furniture have made the subject a much more exact one. The present book is an historical survey of the evolution of furniture making in this country. There are several appendices, over 100 line drawings, and 64 pages of plates.

JAPANESE SCREEN PAINTING. *Introduction and notes by Basil Gray. Faber,* 1955. 12*s* 6*d*

The author's introduction gives an historical sketch of the development of the art, with particular reference to the period after the fifteenth century. The colour plates, of which there are nine, are of screens painted in the sixteenth to eighteenth centuries.

I BUILT A BRIDGE AND OTHER POEMS. *By David B. Steinman, The Davidson Press,* 1955. $2

'With light of faith to set his spirit free
Man builds a bridge to span eternity'.

Bridges and bridge-building form a branch of engineering which appears frequently to transcend the purely mechanical aspects. The author of these poems, a most distinguished member of the profession, puts into verse his lifetime's work on bridges.

FROM THE JOURNAL OF 1856

VOLUME IV. 13*th June,* 1856

From a letter on Arresting Fires

Sir,

The suggestion of Mr. Murphy, for arresting fires by the use of salt water, which was printed in No. 185 of the Society's *Journal*, appears to me to be so valuable as to deserve further notice.

Every housewife is familiar with the *fact* that *salt* sprinkled on blazing coals *stops flame*, and hence its use to 'make a clear fire'. For the purpose of arresting fires, water saturated with ALUM will be found even superior to where salt is used, and I take the liberty to suggest (on Mr. Murphy's hint) that the tanks of water on Her Majesty's Theatre and other buildings be saturated with alum, as, should the unfortunate necessity arise, whatever material the alum water falls upon will be rendered nearly incombustible.—SEPTIMUS PIESSE.